Remarks

Thorough examination by the Examiner is noted and appreciated.

The claims have been amended and new claims have been added to clarify Applicants invention.

Support for the new claims is found in the original claims, The Specification and The Figures.

No new matter has been added.

For example support for the amendments and new claims is found in Figure 2 and in the Specification at:

Paragraph 0024:

According to the present invention, it has been found that the SRO layers e.g., 18A and 18C which are formed to sandwich the PE Oxide layer 18B act to **prevent undesired reactions at an electrode/PE Oxide interface including interdiffusion of Si and O from the PE Oxide layer and Ta or nitrogen from the adjacent Ta, TaN, or TaSiN electrode layers.** For example, without the SRO layers according to the prior art methods, reaction between the PECVD oxide layer and the electrodes occurs, causing thinning of the PECVD Oxide layer (capacitive dielectric) and roughening of the electrode surface which degrades the capacitance value and Q factor of the MIM structure. It is believed that interdiffusion between the PECVD oxide layer and the electrodes

causes thinning of the PECVD layer as well as spiking of interstitial Ta atoms across the electrode/PECVD interface to form capacitive dielectric composites thereby degrading capacitive behavior, eventually cases causing electrical shorting and early failure of the MIM structure."

Paragraph 0020:

"It will be appreciated that the silicon containing plasma gas source for the PECVD deposition may include silane and/or chlorosilane source gases including silane (SiH_4), disilane (Si_2H_6), trisilane (Si_3H_8), dichlorosilane (SiH_2Cl_2), trichlorosilane ($SiHCl_3$), or mixtures thereof. Preferably, the PECVD deposition is preceded by forming a plasma from the silicon containing source gas source gas and an inert dilution gas, for example argon, to form a silicided TaN layer, e.g., TaSiN in-situ prior to adding the N_2O and/or NO flow to deposit the SRO layer. **The silicon rich oxide (SRO) layer (e.g., protection layer) is formed by the relatively higher degree of incorporation of nitrogen and hydrogen into the SiO_2 layer resulting in a higher density SRO layer with a refractive index greater than the value for conventional stoichiometric PECVD SiO_2 of about 1.46, for example, preferably greater than about 1.48."**

Paragraphs 0026:

According to the present invention, the beneficial effect of the SRO sandwiching layers in reducing or preventing interdiffusion between the PECVD oxide layer and the electrodes is believed to **be related to the relatively higher density of the SRO layers, as evidenced by the refractive index, compared to the PECVD oxide layer as well as the increased presence of nitrogen in the SiO_2 lattice to thereby inhibiting lattice diffusion across the SRO layer interface.** In addition, it has been found **that silicidation of the electrode layer surface, for example TaN to form TaSiN together with an adjacent intervening SRO layer between the electrode and PECVD layer further**

improves a resistance to interfacial diffusion, believed to be due to the higher atomic binding energy of Ti to Si. As a result, the MIM structure can reproducibly achieve design capacitances with closer tolerances while forming more stable and reliable MIM structures.

Claim Rejections under 35 USC 102

1. Claims 25, 26, 34, and 35 stand rejected under 35 USC Section 102(e) as being anticipated by Shimizu et al. (USPUB 2005/0040481).

Shimizu et al. disclose an insulator layer for achieving a quantum well structure in a gate dielectric or an MIM capacitor structure (see Abstract), where the insulator layer includes barrier layers **(barrier to electrons)** sandwiching a well layer having a high dielectric constant (permittivity) and a lower bandgap and the barrier layers have a lower permittivity and a higher bandgap than the well layer (see Abstract). In the context of an MIM structure, the electrodes are disclosed to be SrRuO3 (see item 53, Figure 14), on a SrTio3 substrate, the barrier layers (5.2 Angstroms thick) are disclosed to be formed of SRO (items 54 and 56) and the capacitor dielectric (item 55)

is disclosed as a perovskite material e.g., SrTiO3 (paragraphs 228; 309-315), having an equivalent oxide thickness of 4.1 Angstroms, and where all the material layers, i.e., electrodes, barrier layers and capacitor dielectric, are epitaxially grown. The barrier layers are disclosed to form a **barrier to electrons** in order to confine the energy levels in the well layer (perovskite type capacitor dielectric) (see paragraph 120). Paragraphs 121 to 125 further explain the **critical relationship** between the material used as the well layer and the barrier layer characteristics (barrier to electrons) and are taught to be **indispensable in forming the quantization of the energy levels** of the quantum well structure of Shimizu et al. (see paragraph 125; ; 171-175; 180).

Thus, Shimizu et al. fail to disclose the elements of Applicants disclosed and claimed invention including:

"An MIM capacitor structure comprising a protection layer **to prevent interdiffusion of electrode metal and capacitor dielectric material:**

a bottom **non-oxide conductive electrode comprising said metal;**

a first protection layer on the bottom conductive electrode;

a dielectric layer comprising **silicon oxide** on the first protection layer; and,

an **upper non-oxide conductive electrode on the dielectric layer comprising said metal.**"

Thus, Shimizu et al. is clearly insufficient to anticipate Applicants disclosed and claimed invention.

"A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987).

"The identical invention must be shown in as complete detail as is contained in the ... claim." *Richardson v. Suzuki Motor Co.*, 868 F.2d 1226, 1236, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989).

Claim Rejections under 35 USC 103

2. Claims 27, 28, 36, and 37 stand rejected under 35 USC Section 103(a) as being unpatentable over Shimizu et al., above, in view of Ohtsuki (USPUB 2002/0098664).

Applicants reiterate the above comments with respect to Shimizu et al.

Ohtsuki discloses a capacitor having a high dielectric constant material or a ferroelectric (disclosed to be PZT) where bottom and top electrodes are formed of platinum and where it is taught that an **SRO or ruthenium layer** may be formed between the PZT and the top and bottom electrodes in a stacked capacitor structure (see Abstract; paragraph 0065; Figure 5, items 110, 111, and 112).

Ohtsuki nowhere teaches the purpose of the SRO layers or why ruthenium can be substituted for SRO.

There is no apparent motivation to combine the teachings of Shimizu et al. and Ohtsuki, since the structure of Ohtsuki is not

a quantum well structure and therefore operate by a different principle of operation. Moreover, there is no teaching for selectively modifying the structure of Shimizu et al. with Ohtsuki by selectively substituting the SRO material of Ohtsuki which serves a completely different function (i.e., is not a quantum well structure taught to serve as a barrier to electrons) into the structure of Ohtsuki.

Even assuming *arguendo*, a proper motivation for combination, such combination fails to produce Applicants disclosed and claimed invention.

Moreover, the combined teachings of Shimizu et al. and Ohtsuki do not recognize the problem that Applicants have recognized and solved by their disclosed and claimed invention:

"An MIM capacitor structure comprising a protection layer to prevent interdiffusion of electrode metal and capacitor dielectric material"

"Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior

art, and not based on applicant's disclosure." *In re Vaeck, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).*

3. Claims 29, 30, 33, and 42 stand rejected under 35 USC Section 103(a) as being unpatentable over Shimizu et al., above, in view of Huang et al. (US 6,916,722).

Applicants reiterate the comments made above with respect to Shimizu et al.

Statement of Common Ownership Pursuant to 35 USC 103(c)

Applicants' attorney of record state that Huang et al. (US 6,916,722) and Applicants instant application were, at the time the invention was made, owned by Taiwan Semiconductor Manufacturing Company. Therefore, Examiners use of Huang et al. as a reference in a 103(a) rejection appears to be improper under 35 USC §103(C).

However, while not agreeing Huang et al. may be properly be used as a reference in a rejection under 103(a), assuming *arguendo* that it is a properly used reference, Applicants

respectfully traverse Examiner's rejection under 35 U.S.C. 103(a).

Even assuming arguendo a proper motivation for combining the quantum well structure of Shimazu et al. with Huang et al., which combination would likely destroy the quantization function of Shimazu et al., the fact that Huang et al. teach that Ta and TaN are known materials for electrodes in an MIM structure does not further help Examiner in producing Applicants disclosed and claimed invention.

Nowhere do the combined teachings of Shimazu et al. and Huang et al. recognize the problem or provide a solution to the problem that Applicants have recognized and solved by their disclosed and claimed invention.

"Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure." *In re Vaeck, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).*

"The fact that references relied upon teach that all aspects of the claimed invention were individually known in the art is not sufficient to establish a prima facie case of obviousness without some objective reason to combine the teachings of the references." *Ex parte Levengood, 28 USPQ2d 1300 (Bd. Pat. App. & Inter. 1993).*

4. Claims 31, 32, 40, and 41 stand rejected under 35 USC Section 103(a) as being unpatentable over Shimizu et al., above,

Applicants reiterate the comments made above with respect to Shimizu et al.

As noted above, the electron barrier layer material (SRO) of Shimizu et al. as well as the material is taught to be critically related to the material type of the well (dielectric) layer material (SrTiO3). In the embodiment for the MIM capacitor, the thickness is disclosed to be 5.2 Angstroms, out side of Applicants range and where Applicants range of thickness and materials, including electrode material would likely destroy the quantum well behavior of the structure of Shimizu et al.

Since Examiner has not shown Applicants structure nor the disclosed and claimed function of Applicants structure, Examiners arguments related to ranges of material thickness cannot further help Examiner in producing Applicants disclosed and claimed invention or establishing a *prima facie* case of obviousness.

"Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure." *In re Vaeck, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).*

"A particular parameter must first be recognized as a result-effective variable, i.e., a variable which achieves a recognized result, before the determination of the optimum or workable ranges of said variable might be characterized as routine experimentation." *In re Antonie,* 559 F.2d 618, 195 USPQ 6 (CCPA 1977)

Conclusion

The cited references, singly or in combination fail to

produce Applicants disclosed and claimed invention, and therefore fail to make out a *prima facie* case of obviousness.

Applicants have amended their claims and have added new claims to clarify Applicants disclosed and claimed invention. Applicants respectfully submit that Applicants Claims are now in condition for allowance. Such favorable action by the Examiner at an early date is respectfully solicited.

In the event that the present invention as claimed is not in a condition for allowance for any other reasons, the Examiner is respectfully invited to call the Applicants' representative at his Bloomfield Hills, Michigan office at (248) 540-4040 such that necessary action may be taken to place the application in a condition for allowance.

Respectfully submitted,

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